

Dynamic Study of Parabolic Cylindrical Shell: A Parametric Study

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ABSTRACT

The shell structures are composed of a thin shell made of reinforced concrete without the use of interior columns giving an open on the inside. Most general shells used in manufacturing industries are flat plates and domes but different shapes like cylindrical, parabolic or spherical section may also used. Storage facilities and Games arena buildings are common concrete shell structures. On the other hand, they can be complicated to design, as the exact shape necessary for stability of structure depends on the material used, the size of the shell, exterior or interior loading, and other oblique. So by varying the parameter of the shell, performance of the shell is also varying. Main objective of this paper is parametric analysis of the various cylindrical shell structures with different lengths. For analysis we took two different lengths of cylindrical shell and then, two parameters have been vary first one is radius and second is thickness, on the basis of different radius and thickness for same chord width, length, and material of shell we will evaluate the behaviour of shell for different models.

KEYWORDS: Multiple cylindrical shells, Analysis, Different Parameter, shell structures, parametric analysis

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INTRODUCTION

Concrete circular cylindrical shells have been widely used for roofing large column-free areas and have been constructed in various countries for almost half a century. From architectural and functional points of view, shells have their applicability as roofing units in many of the public buildings. These roofs are used where full-size floor areas are required to be covered without obstruction from columns. There are many situations where skew shells are required to cover rather than the plot area having unsymmetrical plot size, inclined corridors verandas, etc. connecting the straight areas are such common situations. Due to architectural and structural point of view it is required to use skew shell in so many situations. some time it is essential to used in ships, sub marines, etc.

The objectives of the present work are:

- To study the behavior of the parabolic cylindrical shell subjected to Dynamic loading conditions.
- Comparison between the behaviors of straight parabolic cylindrical shell vs. skewed parabolic cylindrical shell.
- To conduct parametric studies on such parabolic cylindrical shell roofs having different rises, thicknesses and Skew Angle of shells.
- Plotting the graphs and tables on the behavior of shell (moment, stress, strain, deflection), which will provide the ready to use data for practicing engineers planning to use such type of shells.

SOFTWARE USED

Among the features introduced by the analysis of SAP2000 are modal examination, static and dynamic analysis, linear and nonlinear analysis, and easy analysis. The investigative modeling used in this software is the member type model which means that beams or columns are model using single fundamentals. The layered shell modeling can be possible in SAP2000 which permit any number of layers to be defined in the thickness direction, each with an independent position, thickness, behavior, and material. Material behavior may be non linear. The hysteretic response of the concentrated plasticity at ends of a member can be described by a moment curvature association. SAP2000 can specify for each material one or more stress-strain curves that are used to produce nonlinear hinge properties in frame elements. The different curves can be used for different parts of a frame cross section. For steel and other metal materials, SAP2000 usually only specify one stress-strain curve. A multiplicity of cross sections are available in SAP2000 element library. These sections include rectangular sections as used for modeling the beams and columns of the **Reinforced concrete (RC)** buildings. SAP2000 provides the tools required for easy target analysis as material nonlinearity at discrete, user-defined hinges in frame elements. The hinge properties are created based on easy target analysis regulations found in performance-based procedure. Default hinge properties are provided based on FEMA-356 criteria. Display capabilities in the graphical user interface to generate and plot easy target curves, including demand and capacity curves in spectral ordinates. Capabilities in the graphical user interface to plot

and get information regarding the state of every hinge formed at each step in the easy target analysis.

PROPOSED METHODOLOGY:

For this proposed work single bay cylindrical shell roof having Span 10 m, Length 18 m (i.e. plan area 10m X 18m), rise are 1.5, 2.25 & 3m and Thickness 200,150 & 100 mm with Edge beam 0.300m X .8m taken. Different Models are studied (for dead load, live load and time history analyses) with variation in rise, thickness & skew angle by using SAP-2000. The results of shells are presented in the form of tables and graphs.

METHODOLOGY:

- Finite element method has been used for the numerical analysis.
- Shell is discretised by 9 noded Quadrilateral elements.
- Sap software has been used for analysis.
- Study of Variation in skew angle has been done keeping rise & thickness constant.
- Study of Variation in rise has been done keeping skew angle & thickness constant.
- Study of Variation in thickness has been done keeping skew angle & rise constant.

MODELING

For the analysis of multiple cylindrical shell following dimension are considered which is tabulated in table In the current study main goal is parametric analysis of the shell structure. Following results are formed and compare the results for different models.

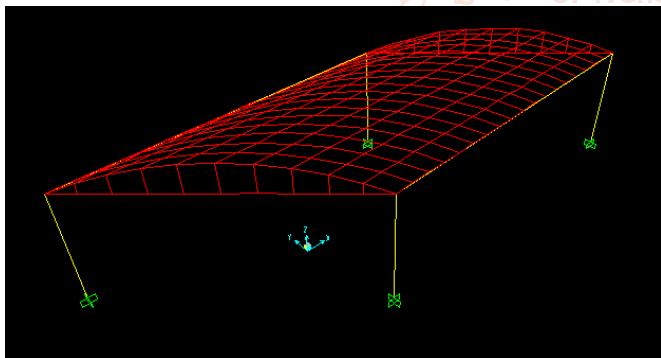


Fig 1.4 Isometric view of skewed parabolic cylindrical shell structure

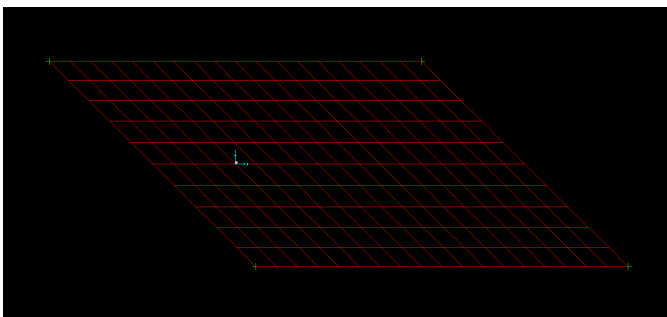


Fig 1.5 Top view of skewed parabolic cylindrical shell structure

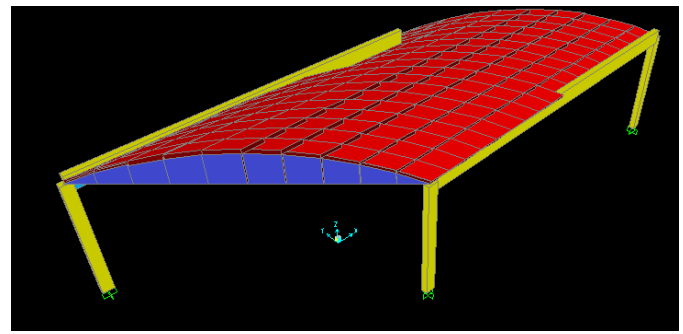


Fig 1.6 3D view of parabolic cylindrical shell structure

PROPERTY AND DIMENSIONS OF MODELS

Span in X direction	11 m
Span in Y direction	11 m
Live load	0.6 kN/m ²
Grade of Concrete	M-25
Type of Steel	HYSD bars
Column Height	5.0 m
Column Size	0.3 m X 1.0 m
Column Support condition	Fixed
Beam Size	0.30 m x 0.50 m
Varying Thicknesses for Radius =	0.08m, 0.12m
Number of bay	3 bay
Semi central angle (Type-A)	40°
Semi central angle (Type-B)	31°
Semi central angle (Type-C)	57°
Radius of model (Type-A)	10.83m
Radius of model (Type-B)	8.56m
Radius of model (Type-C)	6.53m

ANALYSIS RESULT

As mentioned in the objective of the study, the behavior of skewed parabolic cylindrical shells under dynamic loading have been analyzed with varying parameters. The results obtain from the analysis are represent by tables and graphs. Comparison between various Skewed parabolic cylindrical shell and non-skewed parabolic cylindrical shell has been done for different rise, thickness and skew angles in tables and graphs. The linear static analysis is adopted for analysis of various cylindrical shell using structural engineering software SAP-2000 due to static load only. the following analysis result, stresses and force contour are obtain from the analysis for changing thickness and radius for fixed length and chord width of the model which are presented below

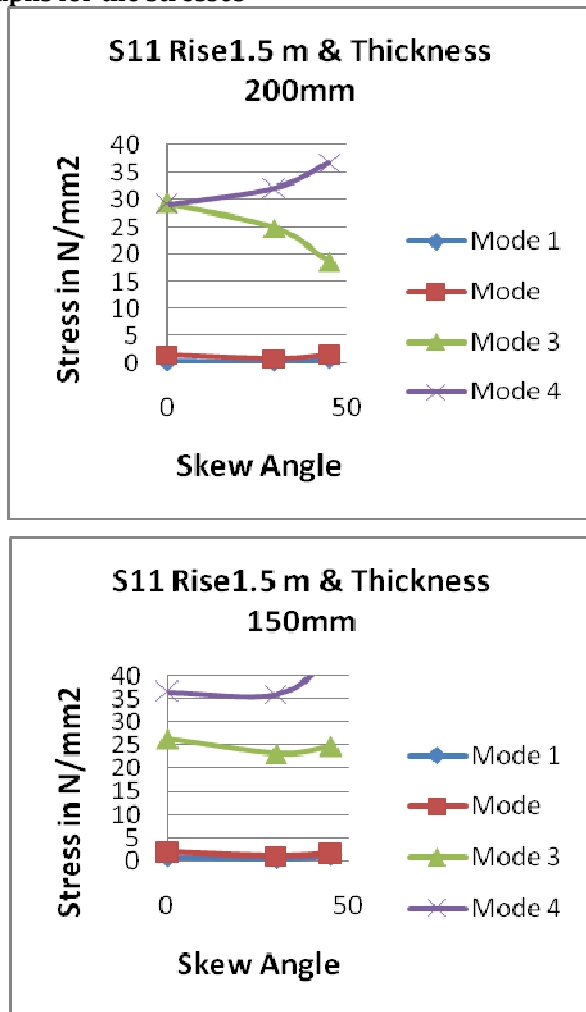
Stresses in longitudinal direction S11 (Nx)

Table No. 4.1 Rise 1.5 m & Thickness 200mm

S11 (N/mm ²)					
Model	skew angle	Mode			
		1	2	3	4
1	0	0.363	1.655	29.279	29.007
10	30	0.29	0.859	24.783	32.104
19	45	0.692	1.551	18.645	36.769

Table No. 4.2 Rise 1.5 m & Thickness 150mm

S11 (N/mm ²)					
Model	skew angle	Mode			
		1	2	3	4
2	0	0.76	1.78	26.382	36.507
11	30	0.451	1.036	23.261	36.056
20	45	1.096	1.489	24.786	43.852

Graphs for the stresses**CONCLUSIONS:**

The observations of the study are as follows:

The effect of rise: By increasing the rise stresses are minimum for 2.25m rise, for shallow and deep shell the loads are resisted by stresses as compare to intermediate rise. Shells with intermediate rise moment plays major role. Transverse normal shear is played negligible part in loads resistance.

The effect of thickness: longitudinal stresses plays major role in resisting the loads compare to other two stresses, the transverse normal stress is negligible with thickness. Moments are increasing with thickness. Transverse moment increases more in comparison of longitudinal moments.

The effect of skew angle: The longitudinal stress decrease as the skew angle increase, transverse stress increase as the skew angle increases. The in plane shear stress almost remain constraint there for it can be concluded that the role of resistance to load shift from longitudinal stress to transverse as skew angle increases.

Longitudinal Moment does not varies much the transverse moment increases for skew angle in 30, 45 but more increases in 30. Further the transverse moment has more than double in all cases which shows transverse moment plays the major role in resisting the load.

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